PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-267972
(43)Date of publication of application : 15.10.1993

(51)Int.CI. H03H 7/075
H01F 15/00
H01F 17/00

(21)Application number : 04-093488
(22)Date of filing : 19.03.1992

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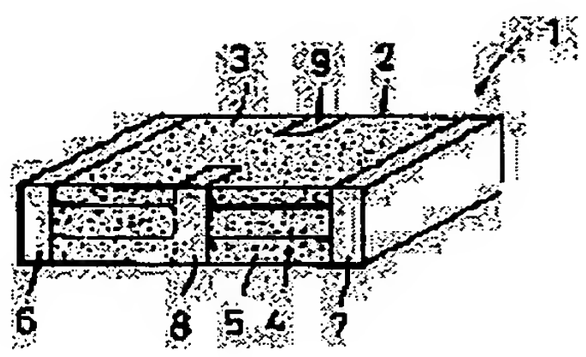
(54) LAMINATED T TYPE LC FILTER

(57)Abstract:
PURPOSE: To provide a material and a structure of the laminated LC filter which can join easily an inductor element part and a capacitor element part, and can be worked easily, and also, to provide a noise eliminating filter whose frequency characteristic is excellent.
CONSTITUTION: Two inductor element parts 3, 5 are formed by laminating a magnetic material ceramics green sheet on which a coil formation electrode is formed, an LC composite element part 4 is formed by laminating a magnetic material on which a capacitor formation electrode and an additional inductor formation electrode are formed and a ceramics green sheet of a mixing material of a dielectric, and also, the LC composite element part 4 is laminated between the inductor element parts 3, 5, and one terminal of each coil formation electrode and one terminal of the additional inductor formation electrode of the LC composite element part 4 are connected through a through-hole.



LEGAL STATUS

[Date of request for examination]	28.01.1998
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3097296
[Date of registration]	11.08.2000
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against	

examiner's decision of rejection]
[Date of extinction of right]

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CLAIMS

[Claim(s)]
[Claim 1] The laminating of the magnetic-substance ceramic green sheet with which the electrode for coil formation was formed is carried out, and it forms the 2 sections of inductor component sections. While the laminating of the ceramic green sheet of the admixture of the magnetic substance and a dielectric with which the electrode for capacitor formation and the electrode for addition inductor formation were formed is carried out and it forms LC compound device section The laminating T mold LC filter which the laminating of said LC compound device section is carried out between said inductor component sections, and is characterized by connecting the end of each of said electrode for coil formation, and the end of the electrode for addition inductor formation of said LC compound device section through a through hole.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a laminating T mold LC filter with sufficient frequency characteristics especially in a large frequency band about the laminating T mold LC filter for noise rejection which consisted of L and C.
[0002]
[Description of the Prior Art] Conventionally, what is shown in drawing 6 is known as a laminating LC filter (for example, T mold LC filter) which consists of a magnetic layer in which two or more coils are contained, and a dielectric layer. This T mold LC filter 100 carries out the laminating of the magnetic-substance ceramic green sheets (henceforth a magnetic-substance sheet) 101-104 constituted as follows, the dielectric ceramic green sheets (henceforth a dielectric sheet) 105-108, and the magnetic-substance sheets 109-112, sticks them by pressure, and has really come to sinter them. The magnetic-substance sheets 101-104 form the inductor component section (A). The magnetic-substance sheet 101 is used as a dummy sheet, and establishes the electrode 113 for coil formation, the cash-drawer electrode 114, and a through hole 115 in the magnetic-substance sheet 102, respectively. The magnetic-substance sheet 103 was made to flow through between through holes 118 from the receiving part 117 which counters a through hole 115 in the electrode 116 for coil formation, it prepared, and the through hole 119 is established in the magnetic-substance sheet 104. The dielectric sheets 105-108 form the capacitor element section (B). The dielectric sheet 105 was used as the dummy sheet, and has formed the through hole 120. The electrode 121 for capacitor formation was formed in the dielectric sheet 106, the through hole 123 was established in this end, and the receiving part 122 is formed in the location which counters the other end in a through hole 120. The grand electrode 124 and through hole 126 for capacitor formation are established in the dielectric sheet 107, and the cash-drawer electrodes 125a and 125b of the both ends of the grand electrode 124 are exposed outside from the edge of the dielectric sheet 107. The through hole 128 is established in the dielectric sheet 109. The magnetic-substance sheets 109-112 form another inductor component section (C). The magnetic-substance sheet 109 was used as the dummy sheet, formed the through hole 128, from the receiving part 130 which counters a through hole 128 in the electrode 129 for coil formation, made it flow through between through holes 131 on the magnetic-substance sheet 110, and is prepared in it. In the magnetic-substance sheet 111, the electrode 132 for coil formation, the receiving part 133 of a through hole 131, and the cash-drawer electrode 134 are formed, and the magnetic-substance sheet 112 is used as the dummy sheet without an electrode at it. And the laminating of the sheets 101-112 is carried out one by one, they are stuck by pressure, and it really sinters, and is considering as laminating T mold LC filter 100 of the equal circuit shown in drawing 5 .
[0003] the inductor component section which consists of a crosswise-lamination object of the magnetic layer and the electrode for coil formation which consist of magnetic-substance sheets, such as a ferrite, as an example similar to the above-mentioned laminating T mold LC filter, and TiO2 BaTiO2 etc. -- the capacitor element section which consists of a crosswise lamination object of the dielectric layer and electrode which consist of a dielectric sheet used as a principal component is superimposed, and the really sintered compound LC filter is known (for example, refer to JP,60-17895,Y). If both burning shrinkage and coefficient of thermal expansion are not made to agree strictly in order to make the magnetic substance and the dielectric which completely consist of an ingredient of a different kind really sinter like this compound LC filter, it is very difficult for layer peeling and a crack to occur and to really obtain a sintered compact. Then, a dielectric is not used for the capacitor element section, but forming the capacitor element section using the dielectric constant which the magnetic substance itself, such as a ferrite, has is proposed (refer to the above-mentioned official report). Since the inductor component section and capacitor element section also consists of the same magnetic-substance ingredient, there is an advantage that the mismatch of burning shrinkage does not really happen on the occasion of sintering.
[0004]
[Problem(s) to be Solved by the Invention] However, the compound LC filter of the dielectric constant of the

magnetic substance, such as a ferrite, which formed the capacitor element section using the dielectric constant which the magnetic substance itself, such as the above-mentioned conventional ferrite, has is small, it is difficult the LC filter to obtain big electrostatic capacity, in order to obtain predetermined electrostatic capacity, the capacitor electrode of many number of sheets of a big area is needed, and it has the trouble of becoming enlargement and a cost rise. Moreover, although it is desirable to use the magnetic substance, such as a ferrite with big permeability, in order to enlarge the inductance of the above-mentioned inductor component section, as for the ferrite with big permeability, permeability falls rapidly by the RF. Consequently, the inductance in a RF becomes small and the noise rejection effectiveness worsens. In a ferrite with small permeability, although there is little decline in permeability to a RF, in order to obtain a big inductance, it is necessary to make [many] the number of turns of a coil, and becomes enlargement and a cost rise.

[0005] This invention aims at offering a laminating T mold LC filter with the noise rejection effectiveness which was made in view of the trouble which the above-mentioned conventional technique has, junction of the inductor component section and the capacitor element section was easy, and was easy to process it, and was excellent in frequency characteristics.

[0006]

[Means for Solving the Problem] The laminating of the magnetic-substance ceramic green sheet with which the electrode for coil formation was formed is carried out, and the laminating T mold LC filter concerning this invention forms the 2 sections of inductor component sections. While the laminating of the ceramic green sheet of the admixture of the magnetic substance and a dielectric with which the electrode for capacitor formation and the electrode for addition inductor formation were formed is carried out and it forms LC compound device section The laminating of said LC compound device section is carried out between said inductor component sections, and it is characterized by connecting the end of each of said electrode for coil formation, and the end of the electrode for addition inductor formation of said LC compound device section through a through hole.

[0007]

[Function] Since this invention is constituted as mentioned above, does not make the magnetic-substance sheet and dielectric sheet which completely consist of an ingredient of a different kind really sinter, but makes the admixture sheet which turns into a magnetic-substance sheet from the magnetic substance and a dielectric adjoin and is really sintered, it can make both burning shrinkage, a coefficient of thermal expansion, etc. approach, and generating of layer peeling or a crack reduces it. Moreover, since inductor ability is constituted from the inductor component section which consists of a magnetic-substance sheet and capacitor ability uses the comparatively big dielectric constant of the admixture of the magnetic substance and a dielectric, electrostatic capacity can be enlarged, it is few in laminating number of sheets, or an electrode surface product can be made small, and a miniaturization can be attained. Furthermore, the magnetic properties of LC compound device section which forms the capacitor which consists of this admixture sheet are excellent in a RF property, and when reduction of the permeability in a RF makes an additional inductor intervene a small top, they can obtain the LC filter for noise rejection with a sufficient RF property.

[0008]

[Example] Hereafter, the example of this invention is explained. First, the following nickel-Zn ferrite and the powder of Pb system relaxer dielectric are mixed, and it considers as the admixture of the magnetic substance and a dielectric.

1) nickel-Zn ferrite: -- nickel0.34Zn0.57Cu0.16Fe1.95O3.972Pb system relaxer : 0.95[Pb(Mg1 / 3 Nb 2/3) O3]-0.05PbTiO3 -- each and the dielectric of these magnetic substance are temporary quenching and the ground fine particles beforehand. The temporary-quenching conditions of these magnetic-substance raw materials and a dielectric raw material can be chosen suitably, respectively, and the burning-shrinkage curve of an admixture can be made the same as that of it of the magnetic-substance single taste by mixing them. Weighing capacity of the powder of the magnetic substance of the above 1 and 2 which adjusted temporary-quenching conditions and grinding conditions, respectively, and the powder of a dielectric was carried out by the weight ratio of Table 1, they were mixed with the binder and the solvent, and the ceramic green sheet (henceforth an admixture sheet) of an admixture was created. Laminating sticking by pressure of the admixture sheet is carried out, and it pierces to a ring and disc-like, it calcinates at 930 degrees C, and considers as a sample. The property of this sample is measured and that result is shown in Table 1.

[0009]

[Table 1]

No.		1	2	3	4	5	6
混合比 (wt%)	Ni-Zn フェライト	100	80	60	40	20	0
	Pb リラクサー	0	20	40	60	80	100
透磁率（1 MHz）		248	104	47	17	6	1
誘電率（1 MHz）		13	77	485	2350	6540	12900
収縮率(%)		14.6	14.6	14.7	14.8	15.0	15.3
焼結開始温度（℃）		655	660	670	685	705	735

[0010] Although contraction differs from sintering initiation temperature by the ferrite single taste (No.1) and the dielectric single taste (No.6) so that clearly from the measurement result of Table 1 of the property of a sample, in the admixture (No.4) which contains a dielectric to 60%, the difference is small. That is, the admixture of matching by one sintering with the magnetic substance (No.1) is better than the dielectric single taste (No.6).
[0011] Subsequently, it explains based on drawing 1 thru/or drawing 3 which shows one example of the laminating T mold LC filter concerning this invention. The inductor component section 3 which 1 is T mold LC filter, and forms an electrode in a magnetic-substance sheet and comes to carry out laminating sticking by pressure in drawing, LC compound device section 4 which contains in an admixture sheet the addition inductor which forms an electrode and comes to carry out laminating sticking by pressure, The laminating of another inductor component section 5 which forms an electrode and comes to carry out laminating sticking by pressure is carried out to a magnetic-substance sheet, unification sintering is stuck by pressure and carried out, it considers as a filter element 2, and the external electrodes 6, 7, 8, and 9 are prepared and constituted in this filter element 2. 10-14, and 24-28 are magnetic-substance sheets, and 15-23 are admixture sheets.
[0012] The electrodes 29, 32, and 35 for coil formation are formed, respectively, and the inductor component section 3 has become the front face of the magnetic-substance sheets 11, 12, and 13, as shown in drawing 2 . It exposed outside, and the end 30 of the electrode 29 of the magnetic-substance sheet 11 was pulled out, formed the electrode, and has connected other ends with the end 33 of the lower electrode 32 through a through hole 31. Similarly, it connects with the end 36 of the electrode 35 under it further through a through hole, and the other end 34 of an electrode 32 forms a coil, and in this way, the laminating of the magnetic-substance sheet is carried out, it is stuck by pressure, and it forms the inductor component section 3.
[0013] Similarly, as shown in drawing 3 , another inductor component section 5 is formed. The electrode 58 for coil formation is formed in the front face of the magnetic-substance sheet 25, and the end is connected with the end 51 of the addition inductor 50 of the admixture sheet 20 through each through hole 57, 56, 55, and 52 of the magnetic material sheet 24 on top and the admixture sheets 23, 22, and 21. The other end 60 is connected with the end 62 of the electrode 61 of the lower magnetic-substance sheet 26 through a through hole, it connects with the end 65 of the electrode 64 of the lower magnetic-substance sheet 27 through the through hole of the other end 63 of this electrode 61 further, and the other end 66 of an electrode 64 forms the cash-drawer electrode exposed outside.
[0014] LC compound device section 4 located in the middle of the two above-mentioned inductor component sections 3 and 5 counters and forms the electrodes 42, 44, 49, and 53 for capacitor formation in the front face of the admixture sheets 17, 18, 20, and 21, respectively, as shown in drawing 3 . Here, electrodes 42 and 53 are grand electrodes, are pulled out at the Edges 43a, 43b, 54a, and 54b, respectively, and are exposed outside as an electrode. From the capacitor electrode 44 which counters the grand electrode 42, the electrode 45 with which it moves for additional inductor formation in a zigzag direction is extended at the edge 46. Similarly, the electrode 50 with which it moves for additional inductor formation in a zigzag direction is extended and formed in the through hole of an edge 51 also from the capacitor electrode 49 which counters other grand electrodes 53. The edge 46 of the electrode 45 with which the front face of the admixture sheet 18 lies in a zigzag line is connected to the end 37 of the coil electrode 35 of the inductor component section 3 through the through holes 41, 40, 39, and 38 of the admixture sheets 17, 16, and 15 on it, and the magnetic-substance sheet 14. Similarly, the edge 51 of the electrode 50 with which everything but the front

face of the admixture sheet 20 moves in a zigzag direction is connected to the end 59 of the coil electrode 58 of another inductor component section 5 through each through hole 52, 55, 56, and 57 of the admixture sheets 21, 22, and 23 under it, and the magnetic-substance sheet 24.

[0015] The representative circuit schematic of the LC filter of the above-mentioned configuration is shown in drawing 4 . Here, it is L1. It reaches, L2 is the inductance formed in the inductor component sections 3 and 5, respectively, and it is L3 and L4. It is the inductance formed in the additional inductor of LC compound device section 4, respectively. Moreover, C1 It is the capacity formed in the capacitor of LC compound device section 4. In said laminating T mold LC filter, if the addition coil electrode which connects said electrode for coil formation and the electrode for capacitor formation is formed in said admixture ceramic green sheet, a RF property is improvable.

[0016] The relation between an insertion loss and frequency characteristics shows the noise rejection effectiveness of the T mold LC noise filter of the above-mentioned example and the conventional example to drawing 7 . In the T mold LC noise filter of the conventional example shown by I in drawing, the insertion loss which becomes large rapidly from near 10MHZ becomes loose from near 100MHZ, and the noise rejection effectiveness is getting worse. On the other hand, an insertion loss becomes large steeply to near hundreds MHZ, it has a big insertion loss in a RF region in the curve shown by RO of this invention, and the noise rejection effectiveness is excellent. This is the effectiveness of an inductor added to LC compound device section 4. Since the admixture of the magnetic substance and a dielectric made the addition inductor intervene while it was excellent in a magnetic RF property, it can hold an impedance high to a RF and demonstrates effectiveness to the noise rejection in a RF.

[0017] In addition, in the above-mentioned example, although the configuration where it moved in a zigzag direction showed the electrode for coil formation of the inductor component section, the configuration of the electrode for coil formation, number of turns, sheet number of sheets, etc. are not restricted to the above-mentioned example, but can be suitably selected according to an operating frequency etc. In addition, this invention is not limited to the above-mentioned example, but in the range which does not change the summary by this contractor, it can be corrected, can be changed and can be carried out.

[0018]

[Effect of the Invention] In the laminating T mold LC filter of this invention, by using the admixture of the magnetic substance and a dielectric for the capacitor formation section While a big dielectric constant is obtained, being able to constitute the capacitor formation section from a capacitor element of a small electrode surface product or small number of sheets, being that the cost is cut down and a miniaturization becoming possible from the magnetic-substance single taste Since the mismatch of the contraction at the time of one sintering with the magnetic substance of the inductor component section can be reduced, the LC filter which prevents defects, such as a crack and separation, and has the reliable outstanding noise rejection effectiveness can be obtained.

[Translation done.]

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TECHNICAL FIELD

[Industrial Application] This invention relates to a laminating T mold LC filter with sufficient frequency characteristics especially in a large frequency band about the laminating T mold LC filter for noise rejection which consisted of L and C.

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PRIOR ART

[Description of the Prior Art] Conventionally, what is shown in drawing 6 is known as a laminating LC filter (for example, T mold LC filter) which consists of a magnetic layer in which two or more coils are contained, and a dielectric layer. This T mold LC filter 100 carries out the laminating of the magnetic-substance ceramic green sheets (henceforth a magnetic-substance sheet) 101-104 constituted as follows, the dielectric ceramic green sheets (henceforth a dielectric sheet) 105-108, and the magnetic-substance sheets 109-112, sticks them by pressure, and has really come to sinter them. The magnetic-substance sheets 101-104 form the inductor component section (A). The magnetic-substance sheet 101 is used as a dummy sheet, and establishes the electrode 113 for coil formation, the cash-drawer electrode 114, and a through hole 115 in the magnetic-substance sheet 102, respectively. The magnetic-substance sheet 103 was made to flow through between through holes 118 from the receiving part 117 which counters a through hole 115 in the electrode 116 for coil formation, it prepared, and the through hole 119 is established in the magnetic-substance sheet 104. The dielectric sheets 105-108 form the capacitor element section (B). The dielectric sheet 105 was used as the dummy sheet, and has formed the through hole 120. The electrode 121 for capacitor formation was formed in the dielectric sheet 106, the through hole 123 was established in this end, and the receiving part 122 is formed in the location which counters the other end in a through hole 120. The grand electrode 124 and through hole 126 for capacitor formation are established in the dielectric sheet 107, and the cash-drawer electrodes 125a and 125b of the both ends of the grand electrode 124 are exposed outside from the edge of the dielectric sheet 107. The through hole 128 is established in the dielectric sheet 109. The magnetic-substance sheets 109-112 form another inductor component section (C). The magnetic-substance sheet 109 was used as the dummy sheet, formed the through hole 128, from the receiving part 130 which counters a through hole 128 in the electrode 129 for coil formation, made it flow through between through holes 131 on the magnetic-substance sheet 110, and is prepared in it. In the magnetic-substance sheet 111, the electrode 132 for coil formation, the receiving part 133 of a through hole 131, and the cash-drawer electrode 134 are formed, and the magnetic-substance sheet 112 is used as the dummy sheet without an electrode at it. And the laminating of the sheets 101-112 is carried out one by one, they are stuck by pressure, and it really sinters, and is considering as laminating T mold LC filter 100 of the equal circuit shown in drawing 5 .

[0003] the inductor component section which consists of a crosswise-lamination object of the magnetic layer and the electrode for coil formation which consist of magnetic-substance sheets, such as a ferrite, as an example similar to the above-mentioned laminating T mold LC filter, and TiO2 BaTiO2 etc. -- the capacitor element section which consists of a crosswise lamination object of the dielectric layer and electrode which consist of a dielectric sheet used as a principal component is superimposed, and the really sintered compound LC filter is known (for example, refer to JP,60-17895,Y). If both burning shrinkage and coefficient of thermal expansion are not made to agree strictly in order to make the magnetic substance and the dielectric which completely consist of an ingredient of a different kind really sinter like this compound LC filter, it is very difficult for layer peeling and a crack to occur and to really obtain a sintered compact. Then, a dielectric is not used for the capacitor element section, but forming the capacitor element section using the dielectric constant which the magnetic substance itself, such as a ferrite, has is proposed (refer to the above-mentioned official report). Since the inductor component section and capacitor element section also consists of the same magnetic-substance ingredient, there is an advantage that the mismatch of burning shrinkage does not really happen on the occasion of sintering.

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EFFECT OF THE INVENTION

[Effect of the Invention] In the laminating T mold LC filter of this invention, by using the admixture of the magnetic substance and a dielectric for the capacitor formation section While a big dielectric constant is obtained, being able to constitute the capacitor formation section from a capacitor element of a small electrode surface product or small number of sheets, being that the cost is cut down and a miniaturization becoming possible from the magnetic-substance single taste Since the mismatch of the contraction at the time of one sintering with the magnetic substance of the inductor component section can be reduced, the LC filter which prevents defects, such as a crack and separation, and has the reliable outstanding noise rejection effectiveness can be obtained.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, the compound LC filter of the dielectric constant of the magnetic substance, such as a ferrite, which formed the capacitor element section using the dielectric constant which the magnetic substance itself, such as the above-mentioned conventional ferrite, has is small, it is difficult the LC filter to obtain big electrostatic capacity, in order to obtain predetermined electrostatic capacity, the capacitor electrode of many number of sheets of a big area is needed, and it has the trouble of becoming enlargement and a cost rise. Moreover, although it is desirable to use the magnetic substance, such as a ferrite with big permeability, in order to enlarge the inductance of the above-mentioned inductor component section, as for the ferrite with big permeability, permeability falls rapidly by the RF. Consequently, the inductance in a RF becomes small and the noise rejection effectiveness worsens. In a ferrite with small permeability, although there is little decline in permeability to a RF, in order to obtain a big inductance, it is necessary to make [many] the number of turns of a coil, and becomes enlargement and a cost rise.

[0005] This invention aims at offering a laminating T mold LC filter with the noise rejection effectiveness which was made in view of the trouble which the above-mentioned conventional technique has, junction of the inductor component section and the capacitor element section was easy, and was easy to process it, and was excellent in frequency characteristics.

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MEANS

[Means for Solving the Problem] The laminating of the magnetic-substance ceramic green sheet with which the electrode for coil formation was formed is carried out, and the laminating T mold LC filter concerning this invention forms the 2 sections of inductor component sections. While the laminating of the ceramic green sheet of the admixture of the magnetic substance and a dielectric with which the electrode for capacitor formation and the electrode for addition inductor formation were formed is carried out and it forms LC compound device section The laminating of said LC compound device section is carried out between said inductor component sections, and it is characterized by connecting the end of each of said electrode for coil formation, and the end of the electrode for addition inductor formation of said LC compound device section through a through hole.

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OPERATION

[Function] Since this invention is constituted as mentioned above, does not make the magnetic-substance sheet and dielectric sheet which completely consist of an ingredient of a different kind really sinter, but makes the admixture sheet which turns into a magnetic-substance sheet from the magnetic substance and a dielectric adjoin and is really sintered, it can make both burning shrinkage, a coefficient of thermal expansion, etc. approach, and generating of layer peeling or a crack reduces it. Moreover, since inductor ability is constituted from the inductor component section which consists of a magnetic-substance sheet and capacitor ability uses the comparatively big dielectric constant of the admixture of the magnetic substance and a dielectric, electrostatic capacity can be enlarged, it is few in laminating number of sheets, or an electrode surface product can be made small, and a miniaturization can be attained. Furthermore, the magnetic properties of LC compound device section which forms the capacitor which consists of this admixture sheet are excellent in a RF property, and when reduction of the permeability in a RF makes an additional inductor intervene a small top, they can obtain the LC filter for noise rejection with a sufficient RF property.

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EXAMPLE

[Example] Hereafter, the example of this invention is explained. First, the following nickel-Zn ferrite and the powder of Pb system relaxer dielectric are mixed, and it considers as the admixture of the magnetic substance and a dielectric.

1) nickel-Zn ferrite: -- nickel0.34Zn0.57Cu0.16Fe1.95O3.972Pb system relaxer : 0.95[Pb(Mg1 / 3 Nb 2/3) O3]-0.05PbTiO3 -- each and the dielectric of these magnetic substance are temporary quenching and the ground fine particles beforehand. The temporary-quenching conditions of these magnetic-substance raw materials and a dielectric raw material can be chosen suitably, respectively, and the burning-shrinkage curve of an admixture can be made the same as that of it of the magnetic-substance single taste by mixing them. Weighing capacity of the powder of the magnetic substance of the above 1 and 2 which adjusted temporary-quenching conditions and grinding conditions, respectively, and the powder of a dielectric was carried out by the weight ratio of Table 1, they were mixed with the binder and the solvent, and the ceramic green sheet (henceforth an admixture sheet) of an admixture was created. Laminating sticking by pressure of the admixture sheet is carried out, and it pierces to a ring and disc-like, it calcinates at 930 degrees C, and considers as a sample. The property of this sample is measured and that result is shown in Table 1.
[0009]
[Table 1]

No.		1	2	3	4	5	6
混合比 (wt%)	Ni-Zn フェライト	100	80	60	40	20	0
	Pb リラクサー	0	20	40	60	80	100
透磁率（1 MHz）		248	104	47	17	6	1
誘電率（1 MHz）		13	77	485	2350	6540	12900
収縮率(%)		14.6	14.6	14.7	14.8	15.0	15.3
焼結開始温度（℃）		655	660	670	685	705	735

[0010] Although contraction differs from sintering initiation temperature by the ferrite single taste (No.1) and the dielectric single taste (No.6) so that clearly from the measurement result of Table 1 of the property of a sample, in the admixture (No.4) which contains a dielectric to 60%, the difference is small. That is, the admixture of matching by one sintering with the magnetic substance (No.1) is better than the dielectric single taste (No.6).
[0011] Subsequently, it explains based on drawing 1 thru/or drawing 3 which shows one example of the laminating T mold LC filter concerning this invention. The inductor component section 3 which 1 is T mold LC filter, and forms an electrode in a magnetic-substance sheet and comes to carry out laminating sticking by pressure in drawing, LC compound device section 4 which contains in an admixture sheet the addition inductor which forms an electrode and comes to carry out laminating sticking by pressure, The laminating of another inductor component section 5 which forms an electrode and comes to carry out laminating sticking by pressure is carried out to a magnetic-substance

sheet, unification sintering is stuck by pressure and carried out, it considers as a filter element 2, and the external electrodes 6, 7, 8, and 9 are prepared and constituted in this filter element 2. 10-14, and 24-28 are magnetic-substance sheets, and 15-23 are admixture sheets.

[0012] The electrodes 29, 32, and 35 for coil formation are formed, respectively, and the inductor component section 3 has become the front face of the magnetic-substance sheets 11, 12, and 13, as shown in drawing 2 . It exposed outside, and the end 30 of the electrode 29 of the magnetic-substance sheet 11 was pulled out, formed the electrode, and has connected other ends with the end 33 of the lower electrode 32 through a through hole 31. Similarly, it connects with the end 36 of the electrode 35 under it further through a through hole, and the other end 34 of an electrode 32 forms a coil, and in this way, the laminating of the magnetic-substance sheet is carried out, it is stuck by pressure, and it forms the inductor component section 3.

[0013] Similarly, as shown in drawing 3 , another inductor component section 5 is formed. The electrode 58 for coil formation is formed in the front face of the magnetic-substance sheet 25, and the end is connected with the end 51 of the addition inductor 50 of the admixture sheet 20 through each through hole 57, 56, 55, and 52 of the magnetic material sheet 24 on top and the admixture sheets 23, 22, and 21. The other end 60 is connected with the end 62 of the electrode 61 of the lower magnetic-substance sheet 26 through a through hole, it connects with the end 65 of the electrode 64 of the lower magnetic-substance sheet 27 through the through hole of the other end 63 of this electrode 61 further, and the other end 66 of an electrode 64 forms the cash-drawer electrode exposed outside.

[0014] LC compound device section 4 located in the middle of the two above-mentioned inductor component sections 3 and 5 counters and forms the electrodes 42, 44, 49, and 53 for capacitor formation in the front face of the admixture sheets 17, 18, 20, and 21, respectively, as shown in drawing 3 . Here, electrodes 42 and 53 are grand electrodes, are pulled out at the Edges 43a, 43b, 54a, and 54b, respectively, and are exposed outside as an electrode. From the capacitor electrode 44 which counters the grand electrode 42, the electrode 45 with which it moves for additional inductor formation in a zigzag direction is extended at the edge 46. Similarly, the electrode 50 with which it moves for additional inductor formation in a zigzag direction is extended and formed in the through hole of an edge 51 also from the capacitor electrode 49 which counters other grand electrodes 53. The edge 46 of the electrode 45 with which the front face of the admixture sheet 18 lies in a zigzag line is connected to the end 37 of the coil electrode 35 of the inductor component section 3 through the through holes 41, 40, 39, and 38 of the admixture sheets 17, 16, and 15 on it, and the magnetic-substance sheet 14. Similarly, the edge 51 of the electrode 50 with which everything but the front face of the admixture sheet 20 moves in a zigzag direction is connected to the end 59 of the coil electrode 58 of another inductor component section 5 through each through hole 52, 55, 56, and 57 of the admixture sheets 21, 22, and 23 under it, and the magnetic-substance sheet 24.

[0015] The representative circuit schematic of the LC filter of the above-mentioned configuration is shown in drawing 4 . Here, it is L1. It reaches, L2 is the inductance formed in the inductor component sections 3 and 5, respectively, and it is L3 and L4. It is the inductance formed in the additional inductor of LC compound device section 4, respectively. Moreover, C1 It is the capacity formed in the capacitor of LC compound device section 4. In said laminating T mold LC filter, if the addition coil electrode which connects said electrode for coil formation and the electrode for capacitor formation is formed in said admixture ceramic green sheet, a RF property is improvable.

[0016] The relation between an insertion loss and frequency characteristics shows the noise rejection effectiveness of the T mold LC noise filter of the above-mentioned example and the conventional example to drawing 7 . In the T mold LC noise filter of the conventional example shown by I in drawing, the insertion loss which becomes large rapidly from near 10MHZ becomes loose from near 100MHZ, and the noise rejection effectiveness is getting worse. On the other hand, an insertion loss becomes large steeply to near hundreds MHZ, it has a big insertion loss in a RF region in the curve shown by RO of this invention, and the noise rejection effectiveness is excellent. This is the effectiveness of an inductor added to LC compound device section 4. Since the admixture of the magnetic substance and a dielectric made the addition inductor intervene while it was excellent in a magnetic RF property, it can hold an impedance high to a RF and demonstrates effectiveness to the noise rejection in a RF.

[0017] In addition, in the above-mentioned example, although the configuration where it moved in a zigzag direction showed the electrode for coil formation of the inductor component section, the configuration of the electrode for coil formation, number of turns, sheet number of sheets, etc. are not restricted to the above-mentioned example, but can be suitably selected according to an operating frequency etc. In addition, this invention is not limited to the above-mentioned example, but in the range which does not change the summary by this contractor, it can be corrected, can be changed and can be carried out.

[Translation done.]

* NOTICES *

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a perspective view explaining one example of the laminating T mold LC filter concerning this invention.
[Drawing 2] They are some decomposition perspective views of the above-mentioned example.
[Drawing 3] It is the decomposition perspective view of the other sections of the above-mentioned example.
[Drawing 4] It is the representative circuit schematic of the laminating T mold LC filter concerning this invention.
[Drawing 5] It is the representative circuit schematic of the laminating T mold LC filter of the conventional example.
[Drawing 6] It is a decomposition perspective view explaining the conventional example.
[Drawing 7] It is the graph which shows the frequency characteristics of the insertion loss of the laminating T mold LC filter of this invention and the conventional example.
[Brief Description of Notations]
1 Laminating T Mold LC Filter
3 Five Inductor component section
4 LC Compound Device Section
6, 7, 8, 9 External electrode
10-14 Magnetic-substance sheet
15-23 Admixture sheet
24-28 Magnetic-substance sheet
45 50 Electrode for additional inductor formation
Applicant for a patent Incorporated company Murata Manufacturing surrogate Patent attorney Machida ******

[Translation done.]

* NOTICES *

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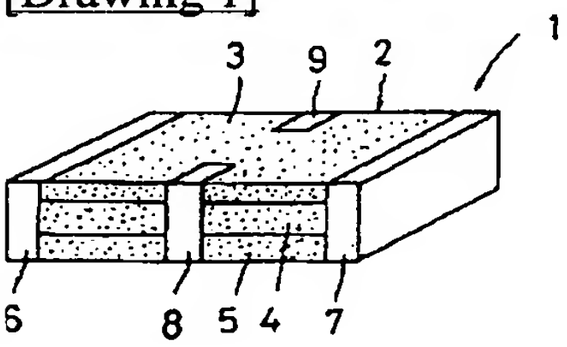
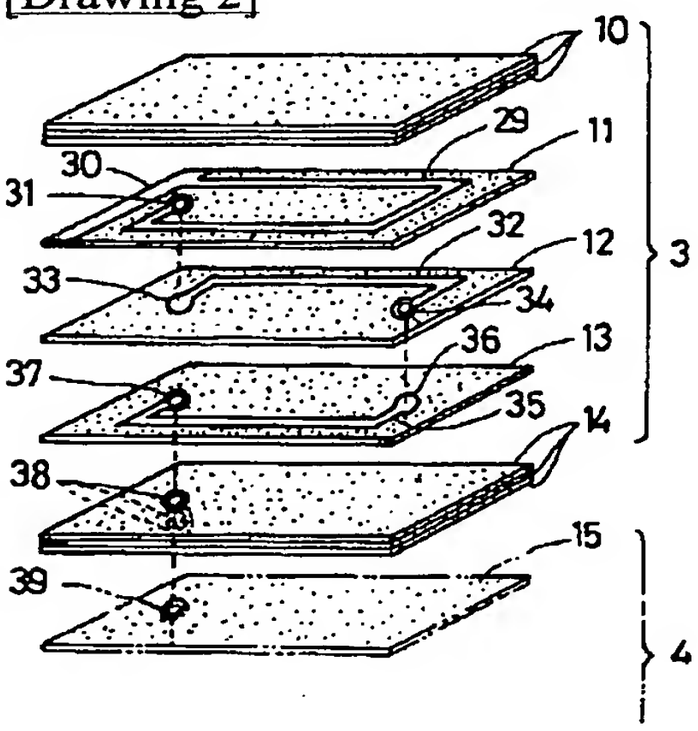
DRAWINGS

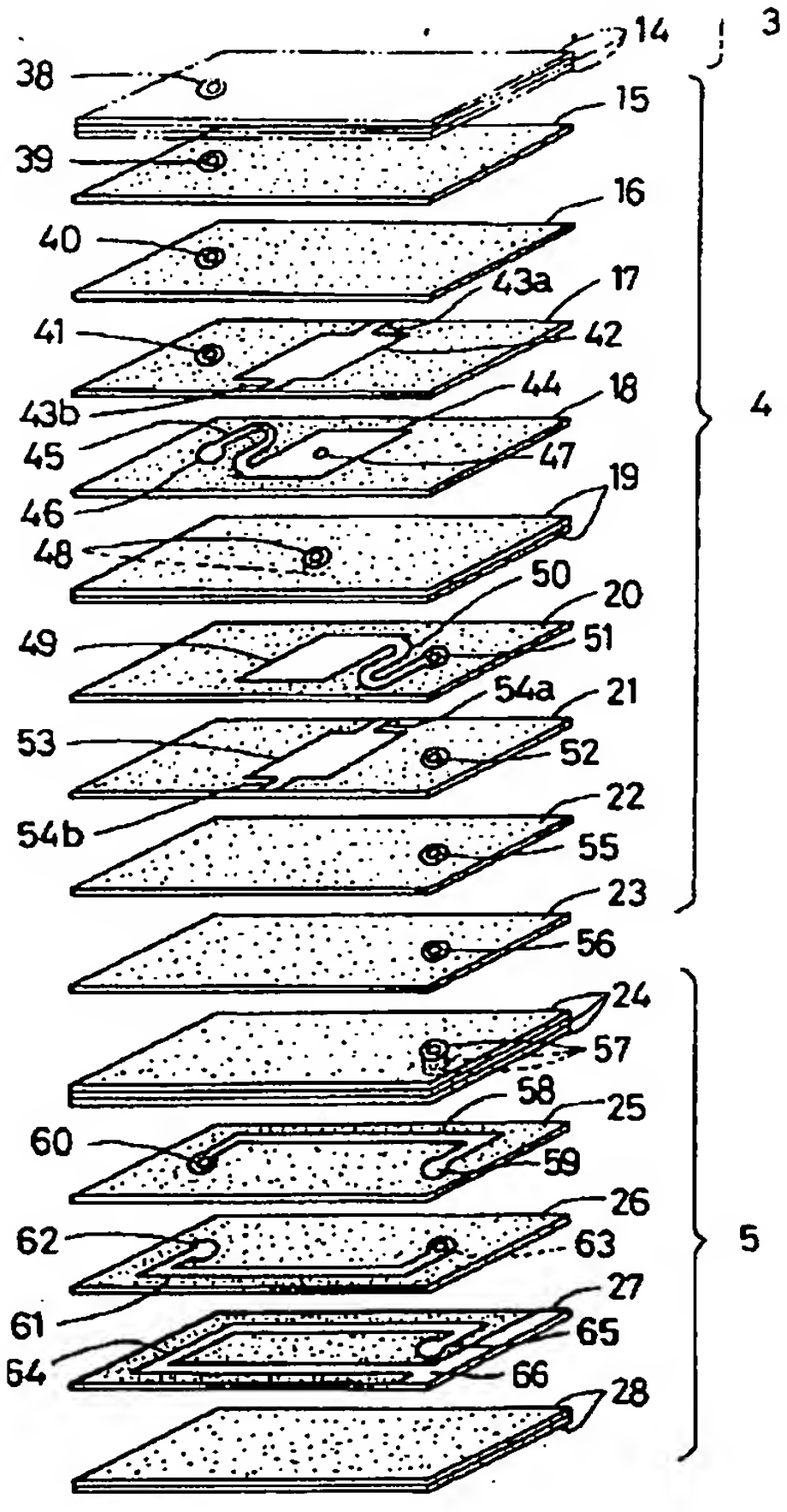
[Drawing 1]



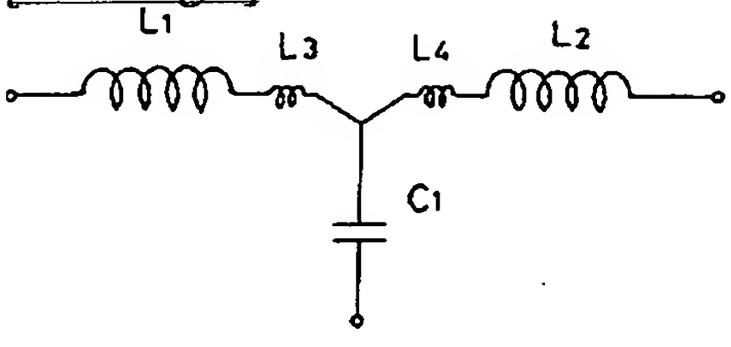
[Drawing 2]



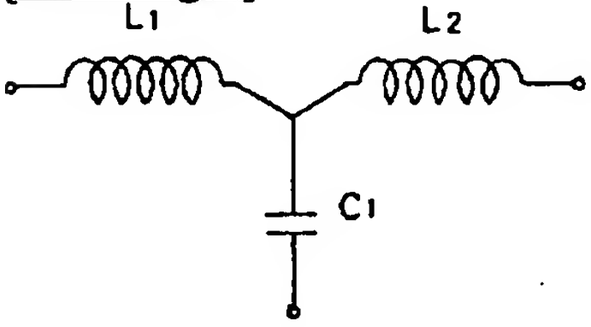
[Drawing 3]



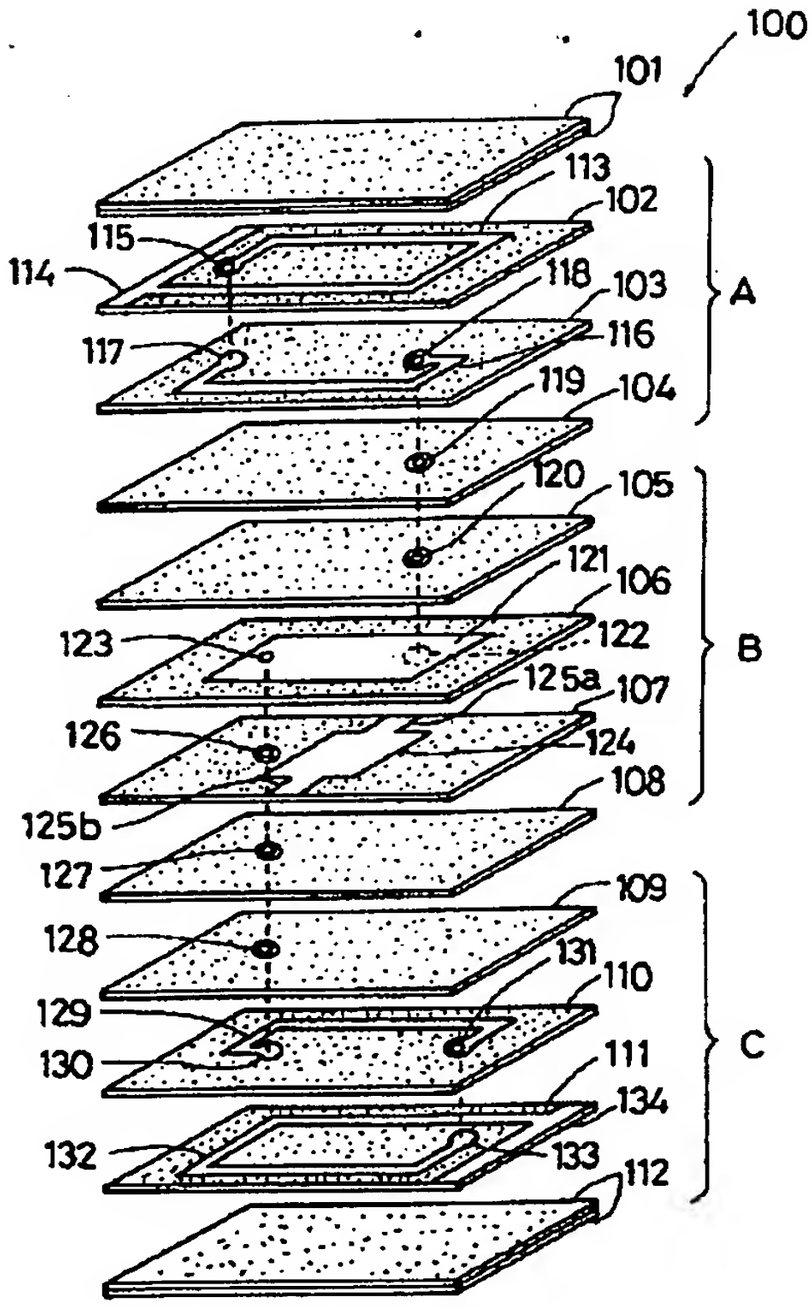
[Drawing 4]



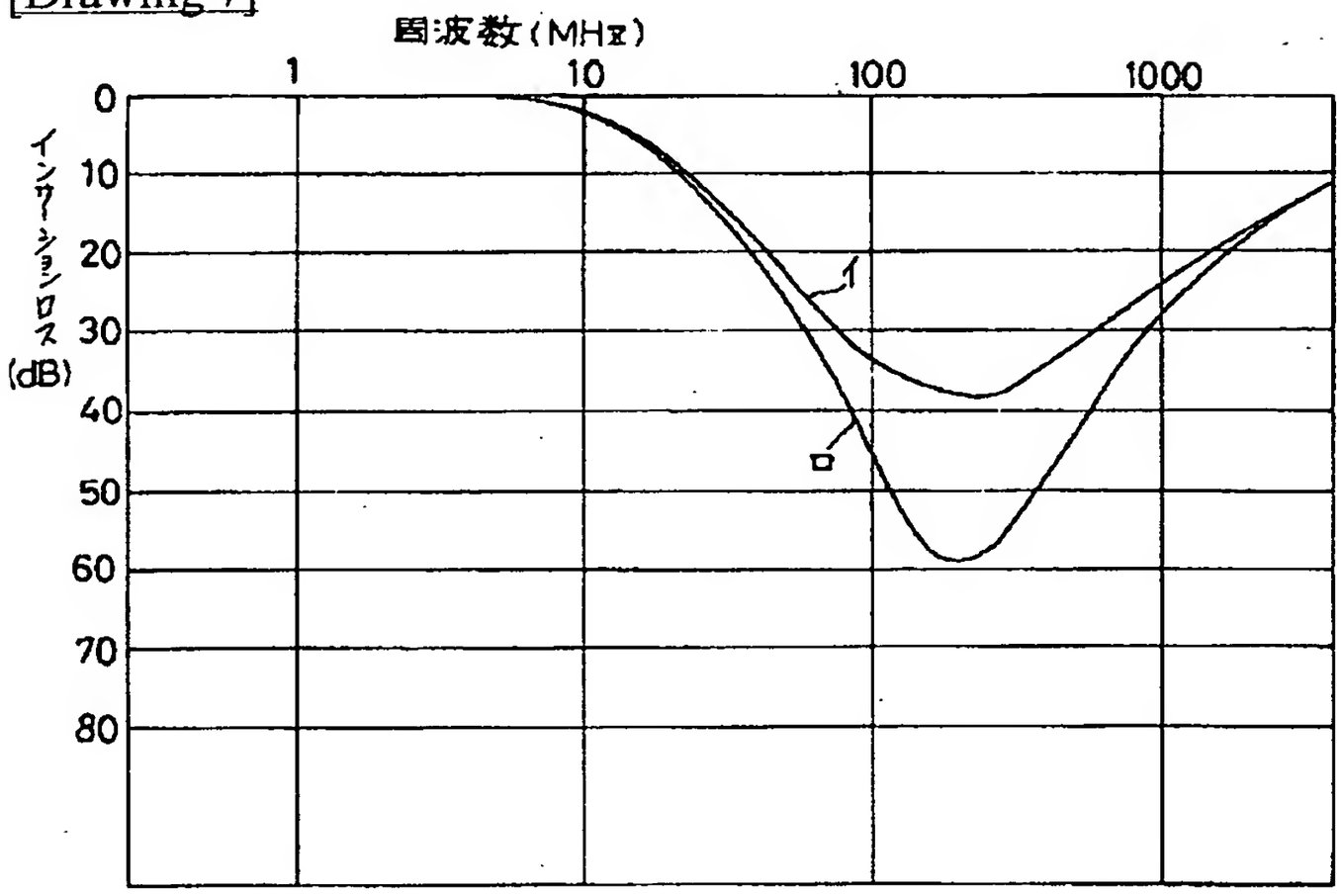
[Drawing 5]



[Drawing 6]



[Drawing 7]



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(19)日本国特許庁（ＪＰ）　(12)**公開特許公報**（Ａ）　(11)特許出願公開番号

特開平5－267972

(43)公開日　平成５年(1993)10月15日

(51)Int.Cl.[5]		識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０３Ｈ	7/075	Ａ	8321－5Ｊ		
Ｈ０１Ｆ	15/00	Ｄ	7129－5Ｅ		
	17/00	Ｄ	7129－5Ｅ		

審査請求　未請求　請求項の数１(全　６　頁)

(21)出願番号　特願平4－93488

(22)出願日　平成４年(1992)３月19日

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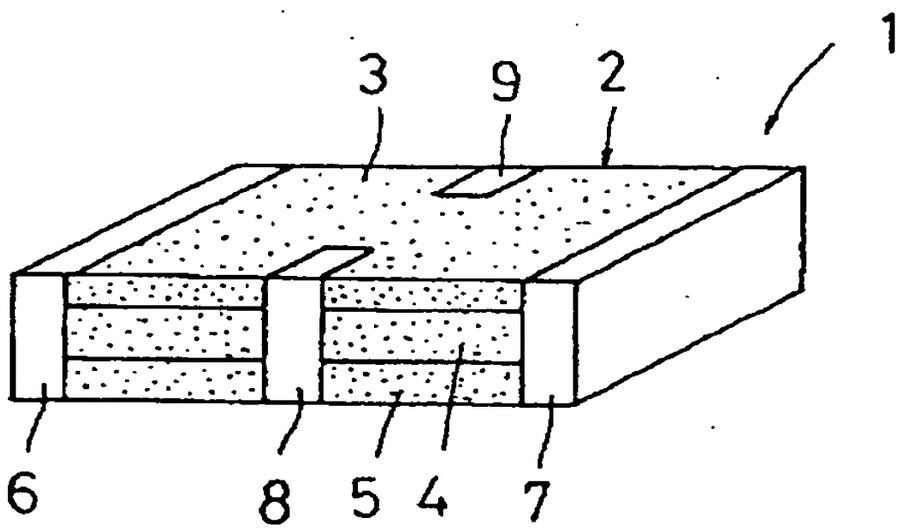
(54)【発明の名称】　積層Ｔ型ＬＣフィルタ

(57)【要約】
【目的】　インダクタ素子部とコンデンサ素子部の接合が容易で、加工しやすい積層ＬＣフィルタの材料及び構造を提供することを目的としている。また、周波数特性の優れたノイズ除去フィルタを提供することを目的としている。
【構成】　コイル形成用電極が形成された磁性体セラミックスグリーンシートが積層されてインダクタ素子部を２部形成し、コンデンサ形成用電極及び付加インダクタ形成用の電極が形成された磁性体と誘電体の混合材のセラミックスグリーンシートが積層されてＬＣ複合素子部を形成するとともに、前記インダクタ素子部間に前記ＬＣ複合素子部が積層され、前記各コイル形成用電極の一端と前記ＬＣ複合素子部の付加インダクタ形成用の電極の一端とをスルーホールを経て接続したことを特徴とする積層Ｔ型ＬＣフィルタ。



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【特許請求の範囲】
【請求項１】　コイル形成用電極が形成された磁性体セラミックスグリーンシートが積層されてインダクタ素子部を２部形成し、コンデンサ形成用電極及び付加インダクタ形成用の電極が形成された磁性体と誘電体の混合材のセラミックスグリーンシートが積層されてＬＣ複合素子部を形成するとともに、前記インダクタ素子部間に前記ＬＣ複合素子部が積層され、前記各コイル形成用電極の一端と前記ＬＣ複合素子部の付加インダクタ形成用の電極の一端とをスルーホールを経て接続したことを特徴とする積層Ｔ型ＬＣフィルタ。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、ＬとＣとから構成されたノイズ除去用の積層Ｔ型ＬＣフィルタに関し、特に広い周波数帯域で周波数特性のよい積層Ｔ型ＬＣフィルタに関する。
【０００２】
【従来の技術】従来、コイルが２個以上含まれる磁性体層と誘電体層とからなる積層ＬＣフィルタ（例えばＴ型ＬＣフィルタ）として、例えば、図６に示すものが知られている。このＴ型ＬＣフィルタ１００は、下記のように構成した磁性体セラミックスグリーンシート（以下磁性体シートという）１０１～１０４、誘電体セラミックスグリーンシート（以下誘電体シートという）１０５～１０８、及び磁性体シート１０９～１１２を積層し、圧着して一体焼結してなっている。磁性体シート１０１～１０４は、インダクタ素子部（Ａ）を形成する。磁性体シート１０１はダミーシートとし、磁性体シート１０２には、それぞれコイル形成用の電極１１３、引出し電極１１４、及びスルーホール１１５を設ける。磁性体シート１０３には、コイル形成用の電極１１６をスルーホール１１５に対向する受部１１７からスルーホール１１８間を導通させて設け、磁性体シート１０４には、スルーホール１１９を設けている。誘電体シート１０５～１０８は、コンデンサ素子部（Ｂ）を形成する。誘電体シート１０５はダミーシートとし、スルーホール１２０を設けている。誘電体シート１０６には、コンデンサ形成用の電極１２１を設け、この一端にスルーホール１２３を設け、他端にスルーホール１２０に対向する位置に受部１２２を設けている。誘電体シート１０７には、コンデンサ形成用のグランド電極１２４とスルーホール１２６とを設け、グランド電極１２４の両端の引出し電極１２５ａ，１２５ｂを誘電体シート１０７の端縁から外部に露出させている。誘電体シート１０９には、スルーホール１２８を設けている。磁性体シート１０９～１１２は、もう１つのインダクタ素子部（Ｃ）を形成する。磁性体シート１０９はダミーシートとし、スルーホール１２８を設け、磁性体シート１１０には、コイル形成用の電極１２９をスルーホール１２８に対向する受部１３０

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からスルーホール１３１間を導通させて設けている。磁性体シート１１１には、コイル形成用の電極１３２、スルーホール１３１の受部１３３、及び引出し電極１３４を設け、磁性体シート１１２は、電極のないダミーシートとしている。そして、シート１０１～１１２を順次積層し、、圧着して一体焼結して、図５に示す等価回路の積層Ｔ型ＬＣフィルタ１００としている。
【０００３】上記の積層Ｔ型ＬＣフィルタに類する一例として、フェライト等の磁性体シートからなる磁性体層とコイル形成用電極との交互積層体よりなるインダクタ素子部と、TiO_2や$BaTiO_2$等を主成分とする誘電体シートからなる誘電体層と電極との交互積層体よりなるコンデンサ素子部を重畳し、一体焼結した複合ＬＣフィルタが知られている（例えば、実公昭６０－１７８９５号公報参照）。この複合ＬＣフィルタのように、全く異種の材料からなる磁性体と誘電体を一体焼結させるためには、両者の焼成収縮率及び熱膨張係数を厳密に合致させないと、層はがれやクラックが発生し、一体焼結体を得ることは非常に困難である。そこで、コンデンサ素子部に誘電体を用いず、フェライト等の磁性体自身が持っている誘電率を利用してコンデンサ素子部を形成することが提案されている（上記公報参照）。インダクタ素子部もコンデンサ素子部も同一の磁性体材料からなるので、一体焼結に際して焼成収縮のミスマッチが起こらないという利点がある。
【０００４】
【発明が解決しようとする課題】しかし、上記従来のフェライト等の磁性体自身が持っている誘電率を利用してコンデンサ素子部を形成した複合ＬＣフィルタは、フェライト等の磁性体の誘電率は小さく、大きな静電容量を得るのは困難であり、所定の静電容量を得るためには大きな面積の多くの枚数のコンデンサ電極が必要となり、大型化やコストアップになるという問題点がある。また、上記インダクタ素子部のインダクタンスを大きくするためには、透磁率の大きなフェライト等の磁性体を用いることが望ましいが、透磁率の大きなフェライトは高周波で急激に透磁率が低下する。その結果、高周波でのインダクタンスが小さくなりノイズ除去効果が悪くなる。透磁率の小さいフェライトでは高周波まで透磁率の低下は少ないが、大きなインダクタンスを得るためにはコイルのターン数を多くする必要があり、大型化やコストアップとなる。
【０００５】本発明は、上記従来技術の有する問題点に鑑みてなされたものであり、インダクタ素子部とコンデンサ素子部の接合が容易で、加工しやすく、かつ、周波数特性の優れたノイズ除去効果を持つ積層Ｔ型ＬＣフィルタを提供することを目的としている。
【０００６】
【課題を解決するための手段】本発明に係る積層Ｔ型ＬＣフィルタは、コイル形成用電極が形成された磁性体セ

ラミックスグリーンシートが積層されてインダクタ素子部を２部形成し、コンデンサ形成用電極及び付加インダクタ形成用の電極が形成された磁性体と誘電体の混合材のセラミックスグリーンシートが積層されてＬＣ複合素子部を形成するとともに、前記インダクタ素子部間に前記ＬＣ複合素子部が積層され、前記各コイル形成用電極の一端と前記ＬＣ複合素子部の付加インダクタ形成用電極の一端とをスルーホールを経て接続したことを特徴とする。

【０００７】

【作用】本発明は、上記のように構成され、全く異種の材料からなる磁性体シートと誘電体シートとを一体焼結させるのではなく、磁性体シートに磁性体と誘電体とからなる混合材シートとを隣接させて一体焼結するので、両者の焼成収縮率、熱膨張係数等を接近させることができ、層はがれやクラックの発生が低減する。また、インダクタ機能は、磁性体シートからなるインダクタ素子部で構成し、コンデンサ機能は磁性体と誘電体の混合材の比較的大きな誘電率を利用するので、静電容量を大きくでき、積層枚数を少なく、または電極面積を小さくでき、小型化が図れる。さらに、この混合材シートからなるコンデンサを形成するＬＣ複合素子部の磁気特性は高周波特性に優れ、高周波での透磁率の減少が小さいうえ、付加的インダクタを介在させることにより、高周波＊

＊特性のよいノイズ除去用ＬＣフィルタを得ることができる。

【０００８】

【実施例】以下、本発明の実施例を説明する。まず、下記のＮｉ－ＺｎフェライトとＰｂ系リラクサー誘電体の粉末を混合して磁性体と誘電体との混合材とする。

１）Ｎｉ－Ｚｎフェライト：$Ni_{0.34}Zn_{0.37}Cu_{0.15}Fe_{1.93}O_{3.97}$

２）Ｐｂ系リラクサー　　：$0.95\{Pb(Mg_{1/3}Nb_{2/3})O_3\}-0.05PbTiO_3$

これらの各々の磁性体及び誘電体は予め仮焼、粉砕された粉体である。これらの磁性体原料及び誘電体原料の仮焼条件をそれぞれ適当に選び、それらを混合することで、混合材の焼成収縮カーブを磁性体単味のそれと同一にすることができる。それぞれ仮焼条件及び粉砕条件を調節した上記１）、２）の磁性体の粉末と誘電体の粉末を、表１の重量比で秤量し、バインダ、溶剤とともに混合し、混合材のセラミックスグリーンシート（以下混合材シートという）を作成した。混合材シートを積層圧着し、リング及び円板状に打ち抜き、９３０℃で焼成して試料とする。この試料の特性を測定し、その結果を表１に示す。

【０００９】

【表１】

No.		1	2	3	4	5	6
混合比 (wt%)	Ni-Zn フェライト	100	80	60	40	20	0
	Pb リラクサー	0	20	40	60	80	100
透磁率（１MHz）		248	104	47	17	6	1
誘電率（１MHz）		13	77	485	2350	6540	12900
収縮率(%)		14.6	14.6	14.7	14.8	15.0	15.3
焼結開始温度（℃）		655	660	670	685	705	735

【００１０】試料の特性の表１の測定結果から明らかなように、フェライト単味（Ｎｏ．１）と誘電体単味（Ｎｏ．６）とでは、収縮率及び焼結開始温度は異なるが、誘電体を６０％まで含む混合材（Ｎｏ．４）では、その差は小さい。即ち、混合材の方が誘電体単味（Ｎｏ．６）よりも、磁性体（Ｎｏ．１）との一体焼結でのマッチングがよい。

【００１１】次いで、本発明に係る積層Ｔ型ＬＣフィルタの一実施例を示す図１ないし図３に基づいて説明する。図において、１はＴ型ＬＣフィルタで、磁性体シートに電極を形成し積層圧着してなるインダクタ素子部３と、混合材シートに電極を形成し積層圧着してなる付加インダクタを含むＬＣ複合素子部４と、磁性体シートに電極を形成し積層圧着してなるもう１つのインダクタ素子部５とを積層し、圧着して一体化焼結し、フィルタ素子２とし、このフィルタ素子２に外部電極６，７，８，

９を設けて構成している。１０～１４及び２４～２８は磁性体シートであり、１５～２３は混合材シートである。

【００１２】インダクタ素子部３は、図２に示すように、磁性体シート１１，１２及び１３の表面にはコイル形成用の電極２９，３２及び３５がそれぞれ形成されてなっている。磁性体シート１１の電極２９の一端３０は外部に露出して引出し電極を形成し、他の一端はスルーホール３１を介して下の電極３２の一端３３と接続している。同様にして、電極３２の他端３４はスルーホールを介してさらにその下の電極３５の一端３６と接続し、コイルを形成し、このように磁性体シートが積層され圧着され、インダクタ素子部３を形成している。

【００１３】同様にして、図３に示すように、もう一方のインダクタ素子部５が形成されている。磁性体シート２５の表面にはコイル形成用の電極５８が形成され、その一端は上面の磁性材シート２４，及び混合材シート２３，２２，２１のそれぞれのスルーホール５７，５６，５５及び５２を経て混合材シート２０の付加インダクタ５０の一端５１と接続し、他端６０はスルーホールを介して下の磁性体シート２６の電極６１の一端６２と接続し、さらにこの電極６１の他端６３のスルーホールを介して下の磁性体シート２７の電極６４の一端６５と接続し、電極６４の他端６６は外部に露出した引出し電極を形成している。

【００１４】上記２つのインダクタ素子部３，５の中間に位置するＬＣ複合素子部４は、図３に示すように、混合材シート１７，１８，２０及び２１の表面に、それぞれコンデンサ形成用の電極４２，４４，４９及び５３を対向して形成している。ここで、電極４２，５３はグランド電極で、それぞれ端部４３ａ，４３ｂ，５４ａ，５４ｂで引出し電極として外部に露出する。グランド電極４２に対向するコンデンサ電極４４からは、付加的インダクタ形成用の蛇行する電極４５が端部４６に伸びている。同様に、他のグランド電極５３に対向するコンデンサ電極４９からも、付加的インダクタ形成用の蛇行する電極５０が端部５１のスルーホールに伸びて形成されている。混合材シート１８の表面の蛇行する電極４５の端部４６は、その上の混合材シート１７，１６，１５及び磁性体シート１４のスルーホール４１，４０，３９及び３８を介して、インダクタ素子部３のコイル電極３５の一端３７に接続している。同様にして、混合材シート２０の表面の他の蛇行する電極５０の端部５１は、その下の混合材シート２１，２２，２３及び磁性体シート２４のそれぞれのスルーホール５２，５５，５６及び５７を介して、もう一方のインダクタ素子部５のコイル電極５８の一端５９に接続している。

【００１５】上記構成のＬＣフィルタの等価回路図を、図４に示す。ここで、L_1 及びL_2は、それぞれインダクタ素子部３，５に形成されたインダクタンスであり、

L_3及びL_4は、それぞれＬＣ複合素子部４の付加的インダクタに形成されたインダクタンスである。また、C_1はＬＣ複合素子部４のコンデンサに形成される容量である。前記積層Ｔ型ＬＣフィルタにおいて、前記コイル形成用電極とコンデンサ形成用電極とを接続する付加コイル電極を前記混合材セラミックスグリーンシートに形成すると、高周波特性を改善することができる。

【００１６】図７に、上記実施例及び従来例のＴ型ＬＣノイズフィルタのノイズ除去効果を、インサーションロスと周波数特性との関係で示す。図中イで示す従来例のＴ型ＬＣノイズフィルタでは１０ＭＨＺ付近から急激に大きくなるインサーションロスは１００ＭＨＺ付近から緩やかになり、ノイズ除去効果が悪くなっている。一方、本発明のロで示すカーブにおいては、数百ＭＨＺ付近まで急峻にインサーションロスは大きくなり、高周波域で大きなインサーションロスを持ち、ノイズ除去効果が優れている。これは、ＬＣ複合素子部４に付加したインダクタの効果である。磁性体と誘電体の混合材は磁気高周波特性に優れるとともに、付加インダクタを介在させたので、高周波まで高いインピーダンスを保持でき、高周波でのノイズ除去に効果を発揮する。

【００１７】なお、上記実施例において、インダクタ素子部のコイル形成用電極を蛇行した形状で示したが、コイル形成用電極の形状、巻数、シート枚数等は上記実施例に限られず、使用周波数等に応じて適宜に選定することができる。その他、本発明は上記実施例に限定されず、当業者によってその要旨を変更しない範囲で修正、変更して実施することができる。

【００１８】

【発明の効果】本発明の積層Ｔ型ＬＣフィルタにおいて、コンデンサ形成部に、磁性体と誘電体の混合材を使用することで、磁性体単味よりも大きな誘電率が得られ、コンデンサ形成部を小さい電極面積、又は少ない枚数のコンデンサ素子で構成することができ、コストダウンになり、小型化が可能となるとともに、インダクタ素子部の磁性体との一体焼結時の収縮のミスマッチを低減できるので、クラック、ハガレ等の欠陥を防止し信頼性の高い、優れたノイズ除去効果を有するＬＣフィルタを得ることができる。

【図面の簡単な説明】

【図１】本発明に係る積層Ｔ型ＬＣフィルタの一実施例を説明する斜視図である。

【図２】上記実施例の一部の分解斜視図である。

【図３】上記実施例の他部の分解斜視図である。

【図４】本発明に係る積層Ｔ型ＬＣフィルタの等価回路図である。

【図５】従来例の積層Ｔ型ＬＣフィルタの等価回路図である。

【図６】従来例を説明する分解斜視図である。

【図７】本発明と従来例の積層Ｔ型ＬＣフィルタのイン

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サーションロスの周波数特性を示すグラフである。

【符号の簡単な説明】

1	積層Ｔ型ＬＣフィルタ
3，5	インダクタ素子部
4	ＬＣ複合素子部
6，7，8，9	外部電極

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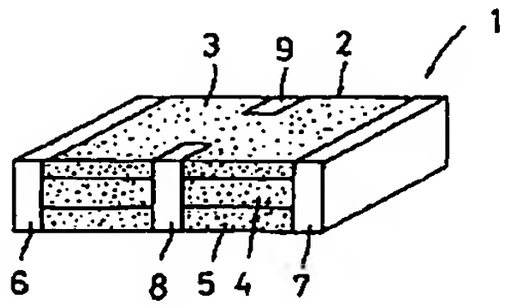
＊１０～１４	磁性体シート
１５～２３	混合材シート
２４～２８	磁性体シート
４５，５０	付加的インダクタ形成用の電極

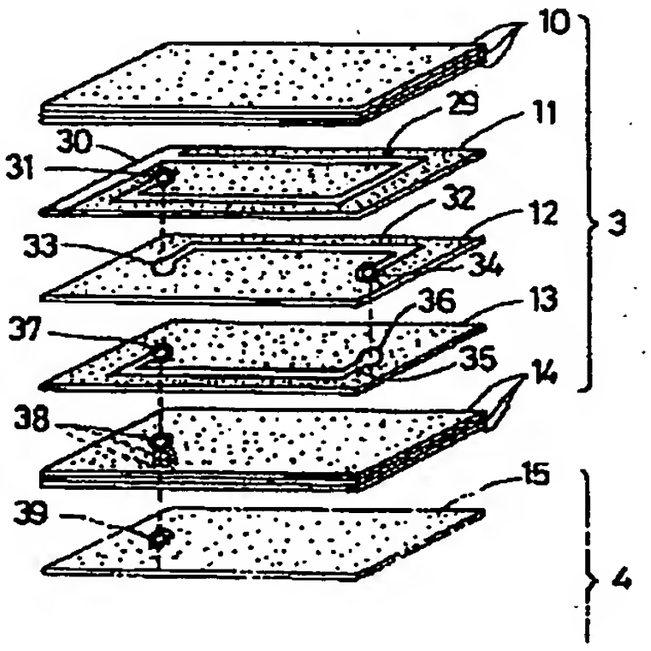
特許出願人　株式会社　村田製作所代理人　　弁理士

＊　　町田　製装治

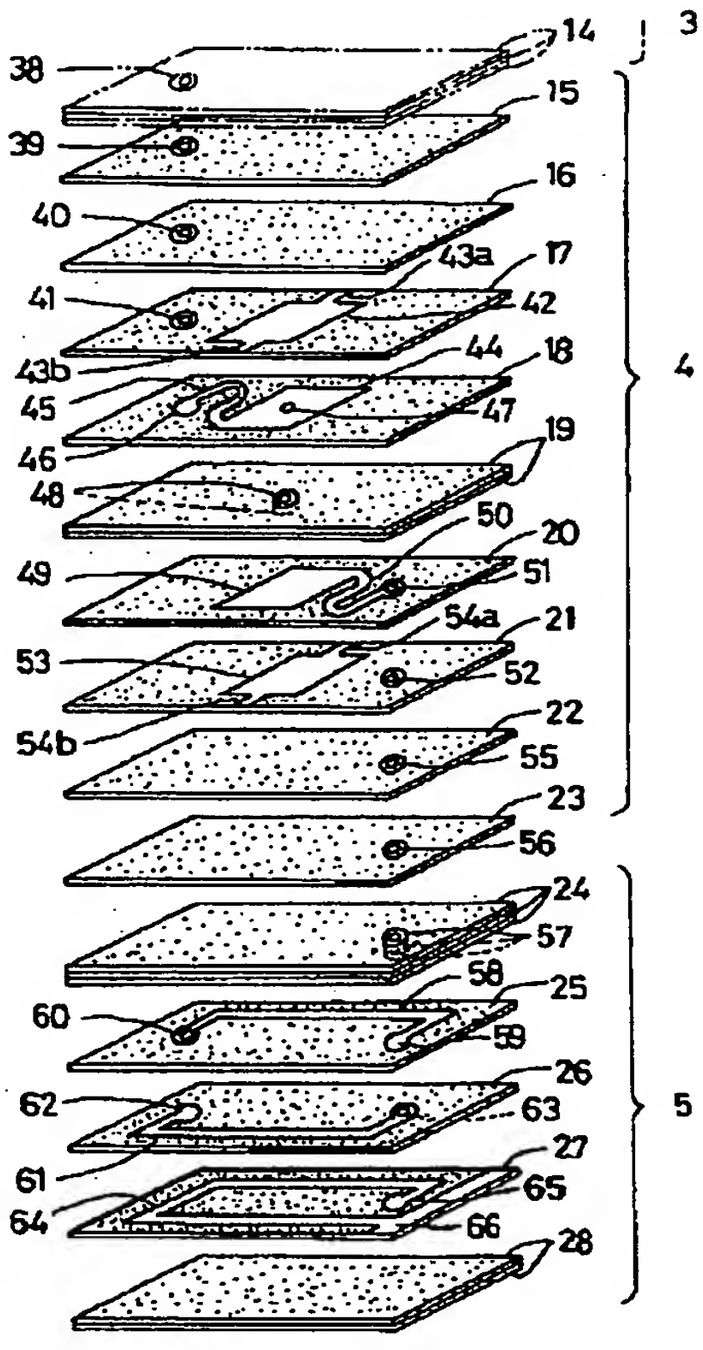
【図１】



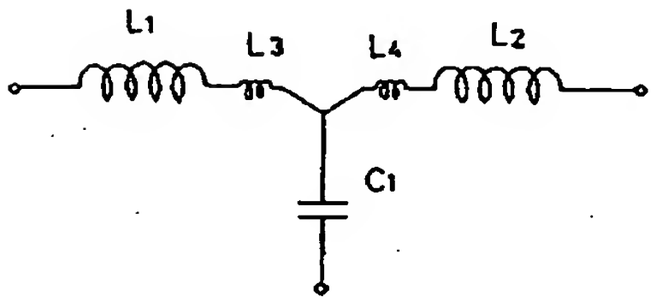
【図２】



【図３】



【図４】



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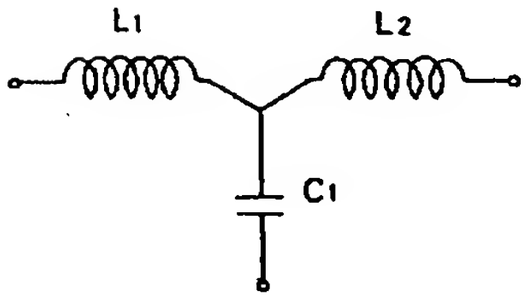
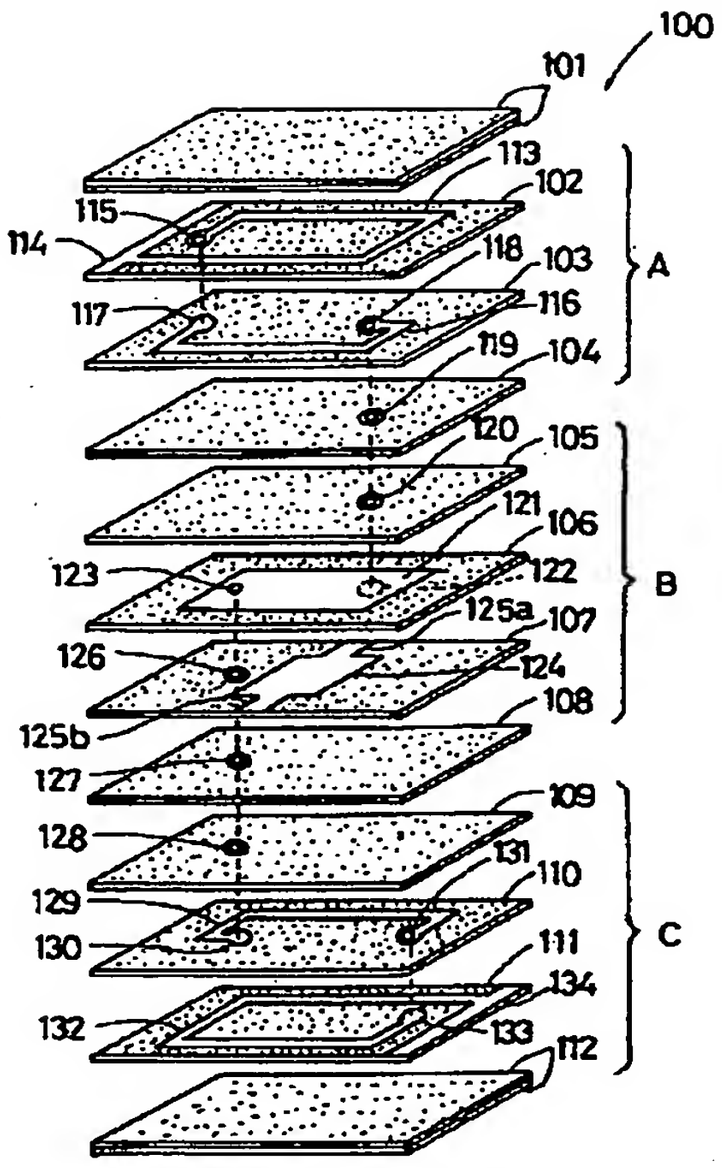


【図６】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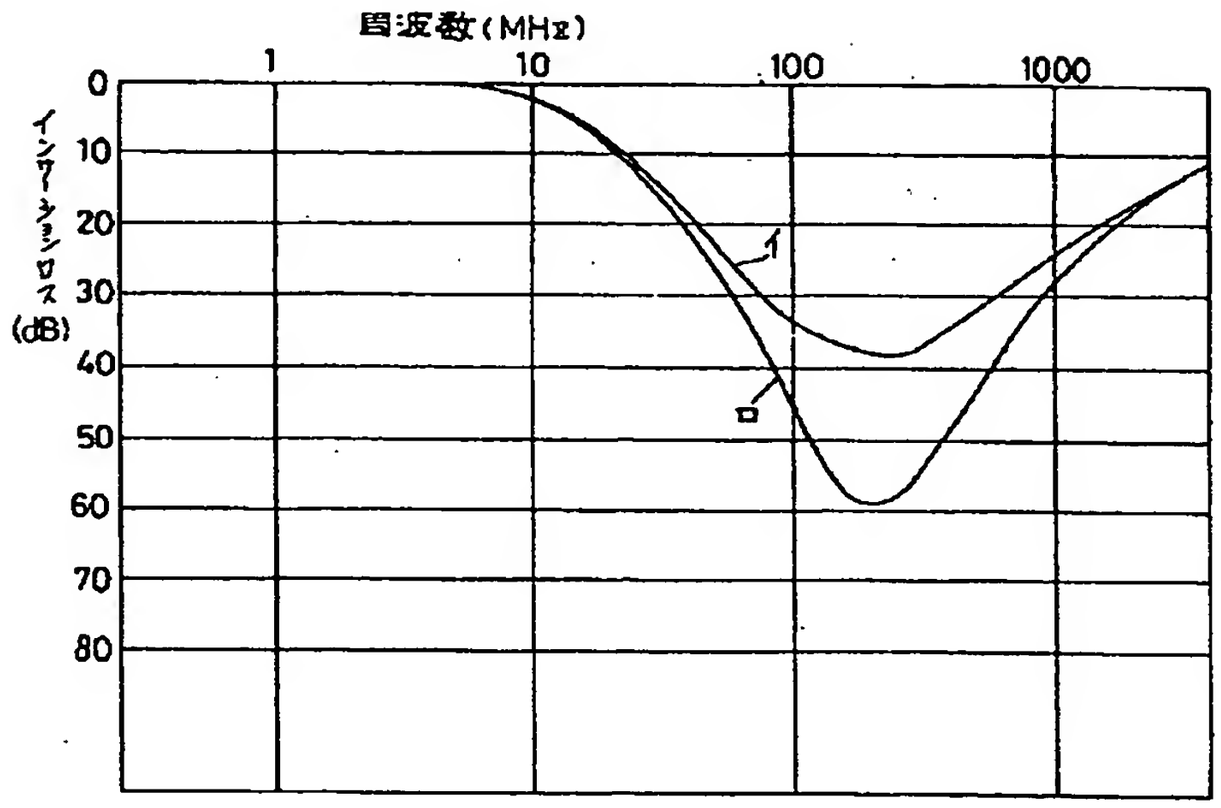
C

【図７】


周波数(MHz)
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1000
0
10
20
30
40
50
60
70
80
インサーションロス
(dB)
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